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SOCIETY OF MAGNETIC
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Activation of the Human Cerebellum Demonstrated by Functional Magnetic Resonance Imaging

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Purpose

Changes in signal intensity have been shown in the cerebral hemispheres secondary to motor activity. To our knowledge, changes in the cerebellum produced by motor tasks have not yet been studied with functional magnetic resonance imaging (FMRI).

Methods

A 1.5 T imager (GE Medical Systems, Waukesha, WI) equipped with an endcapped quadrature experimental rf head coil (1), a three axis gradient head coil and blipped echo-planar gradient acquisitions was used. With a gradient recalled echo (GRE) technique, a series of images was obtained for the purpose of localizing functional image planes and obtaining anatomic reference images. From localizer images in the axial plane, seven sagittal imaging planes were prescribed: contiguous images 15 mm thick located 35 mm from the midline sagittal plane in both cerebellar hemispheres. Functional images were created from a series of 139 images in the selected plane at 2 sec intervals while the subject alternately rested for 20 sec and performed motor tasks used in the neurologic exam for cerebellar function. Signal intensity versus time plots were analyzed for each pixel in each image. The functional images were prepared with n-dimensional vector analysis program (2), which compares the time course plot in each pixel to a reference time course function. The reference function is a synthesized square-wave function with a value of 0 at baseline and 1 during the task. A correlation coefficient is calculated between the time course in each pixel and the reference function.

The motor tasks were rapidly alternating hand movements (RAM), and finger-to-nose testing. A simple motor task of moving the right forearm was also utilized.

The anatomic location of pixels, positive for cerebral activation, was determined by superimposing the functional image on the corresponding GRE image and plate from the Tailarach Atlas (3) to identify specific cerebellar sulci and gyri.

Results

Five subjects were studied. Changes in signal intensity were observed in the cerebellum coincident with motor tasks. Changes in signal intensity in a pixel of the cerebellar vermis that correlate with a standard task of cerebellar function are displayed in Fig. 1. Figure 2 illustrates the signal increases superimposed on the motor cortex and cerebellar vermis with RAM as the task. This image was obtained by preparing the functional images with *n*-dimensional vector analysis program using an ideal square wave functional as a reference and superimposing this on an anatomic (FLASH) image. Cerebellar signal increase was observed to a lesser extent during simple forearm movement.

Conclusion

To our knowledge, this is the first FMRI study of cerebellar signal activity using motor tasks specific for eliciting cerebellar activation. Using FMRI to map the cerebellum may aid us in the understanding of its function as well as in the understanding of cerebellar pathologies ranging from degenerative diseases to tumors.

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